SUMMARY REPORT
ON
SURFACE-WAVE RPOJECT AT
KANSAS GEOLOGICAL SURVEY (KGS)

by

Choon B. Park
Richard D. Miller
Jianghai Xia

Kansas Geological Survey
Open-file Report 97-80

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Summary Report
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Surface-Wave Project at
Kansas Geological Survey (*KGS*)

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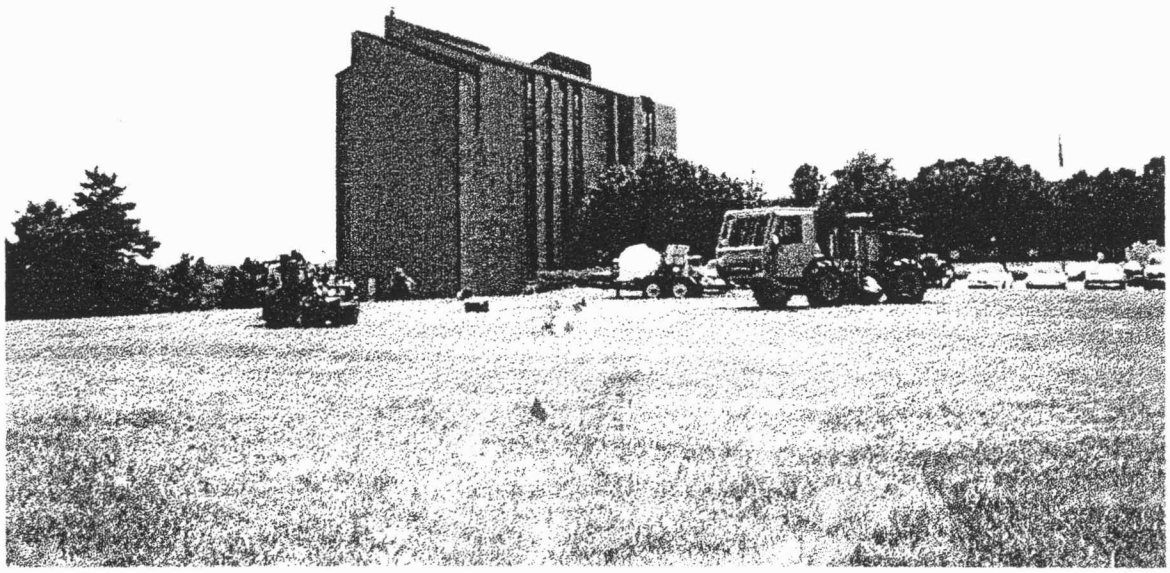
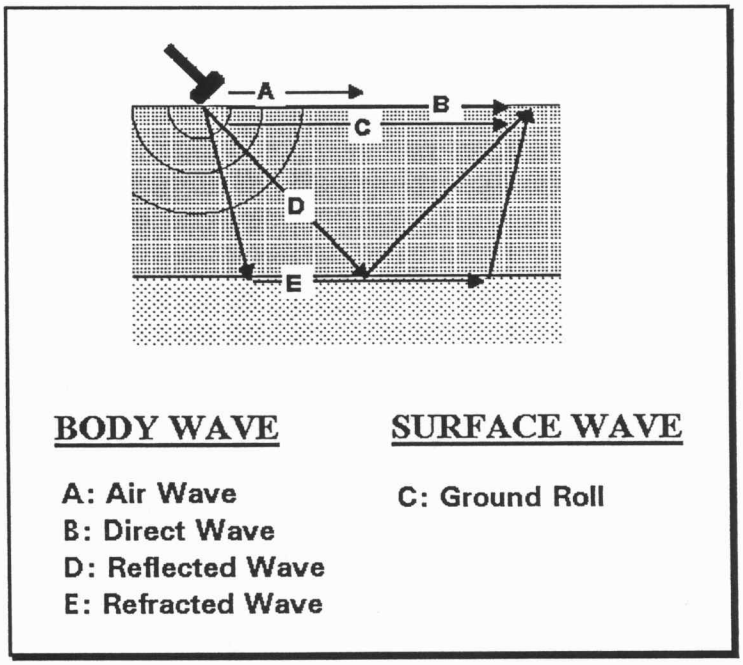


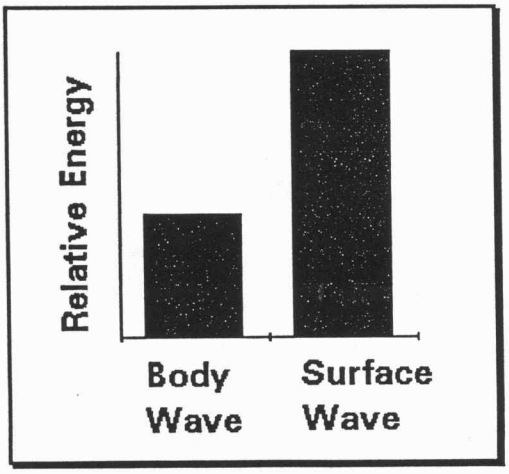
Open-file Report No. 97-80
Kansas Geological Survey
1930 Constant Ave.
Lawrence, Kansas 66047-3726
September 1997

WHAT IS SURFACE WAVE?

- One Type of Elastic Waves
- Elastic Waves = Body + Surface Waves

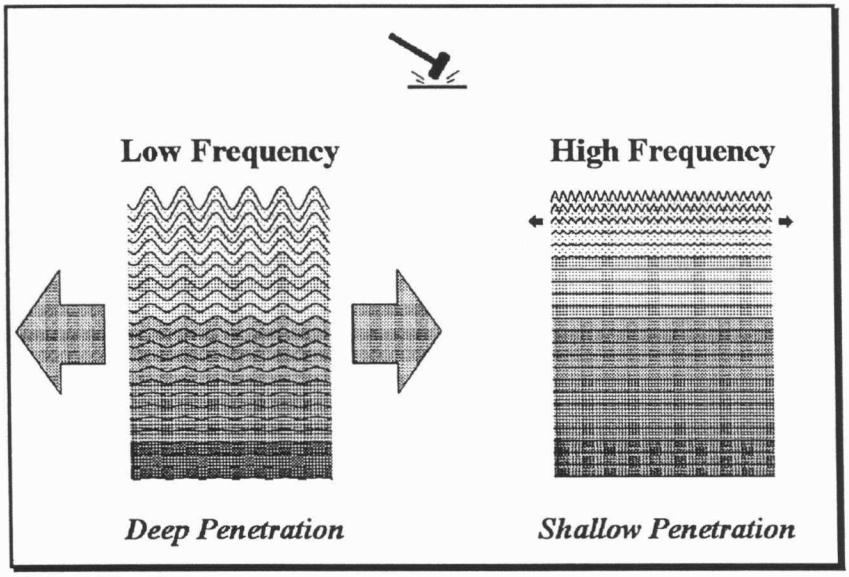


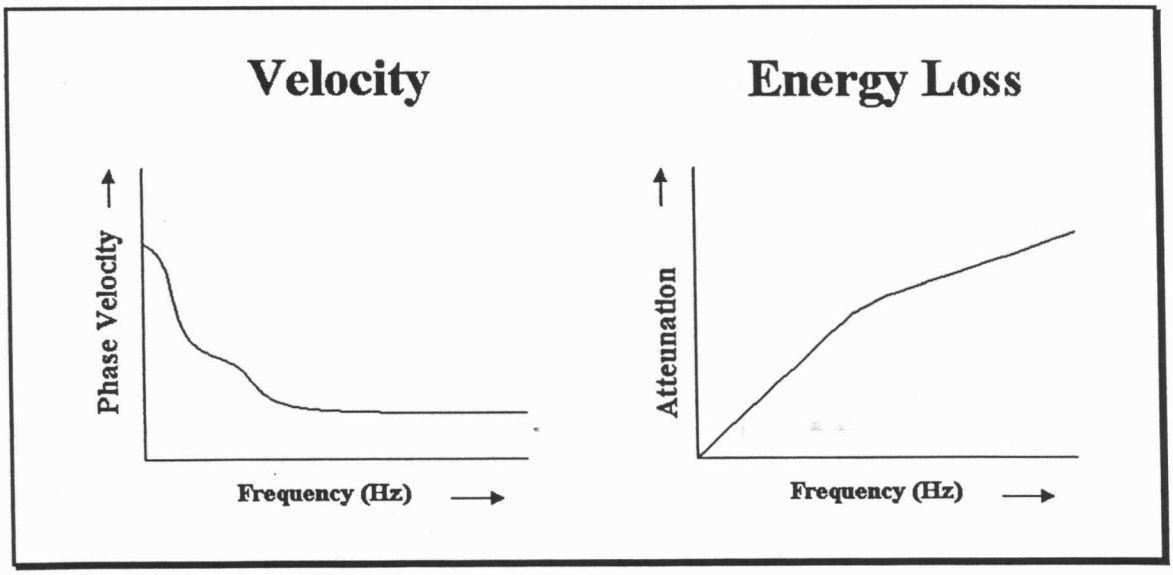
Energy Partitioning



PROPERTIES OF SURFACE WAVES

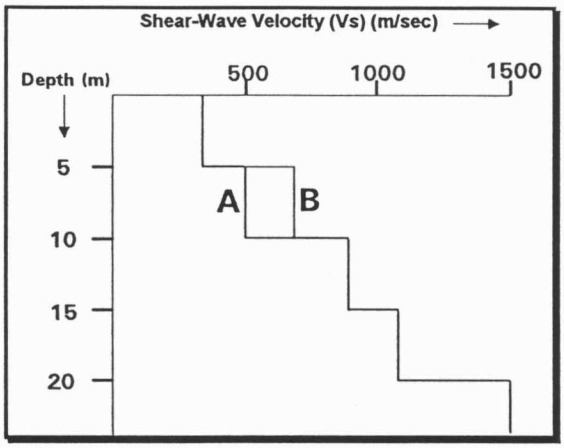
- **Different Penetration for Different Frequency — Different <u>Velocity</u> and <u>Energy Loss</u>**





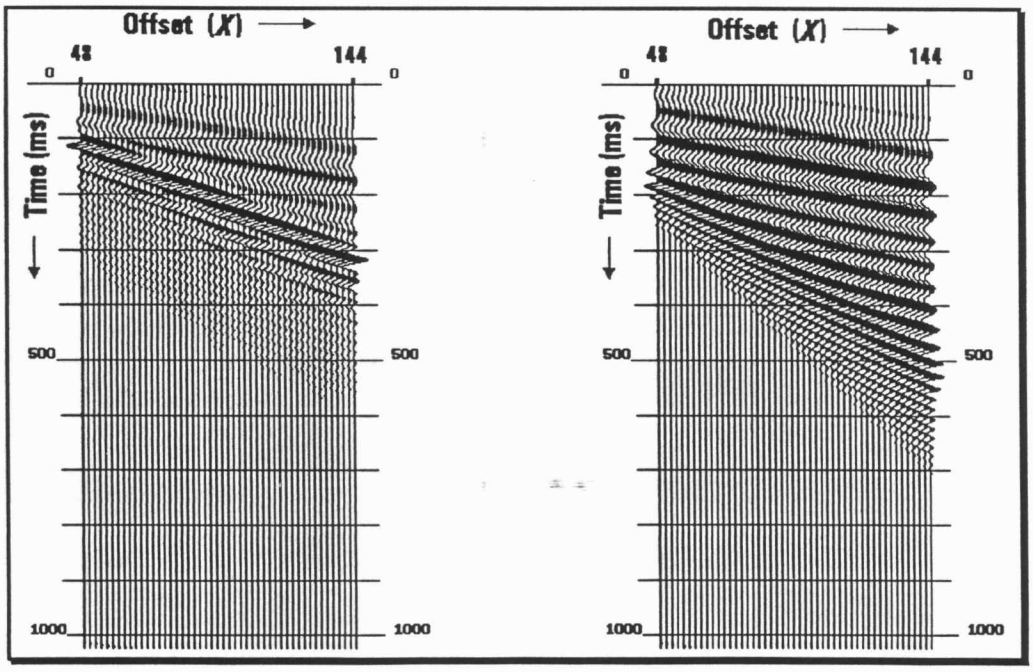
PROPERTIES OF SURFACE WAVES — UNIQUE MEASUREMENT SIGNATURE

Velocity Models



Signature on Multi-Channel Record

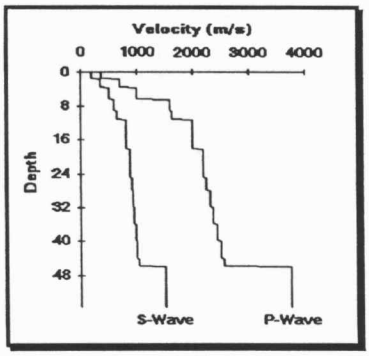
A **B**



SURFACE WAVES — AREAS OF UTILIZATION

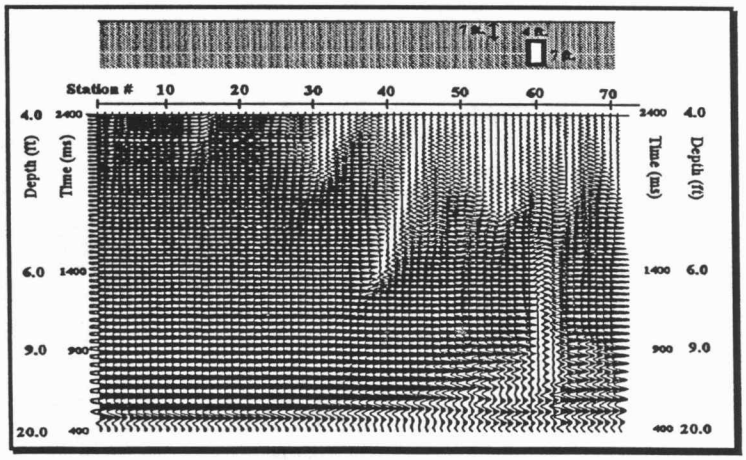
1. S-Wave Velocity (Vs) Profiling

$$\text{Shear - Wave Velocity } (v_s) = \sqrt{\frac{\text{Stiffness of Material}}{\text{Density of Material}}}$$



2. Imaging Near-Surface

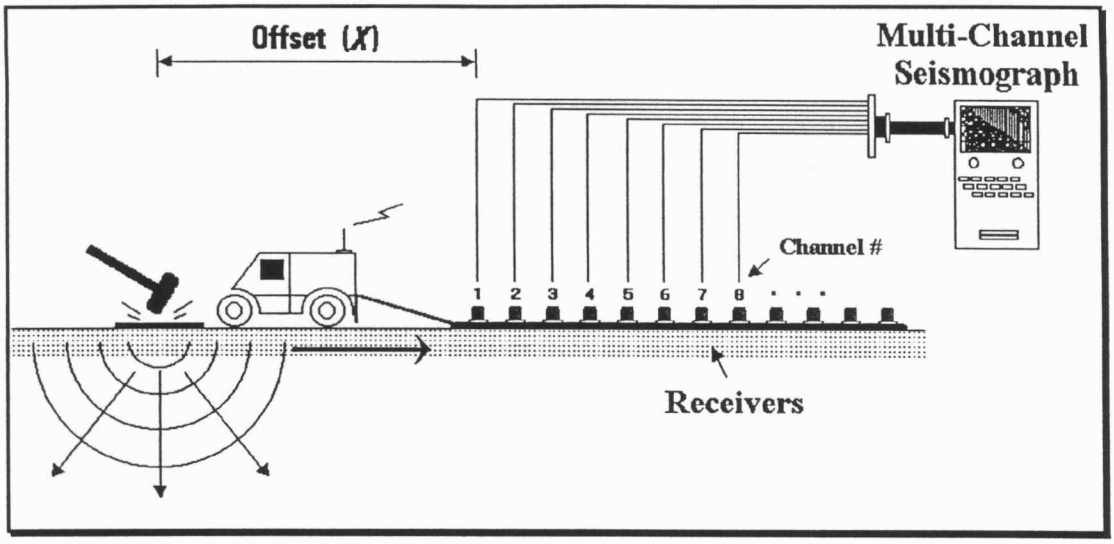
- **Distribution of Vs**
- **Detection of Anomaly**



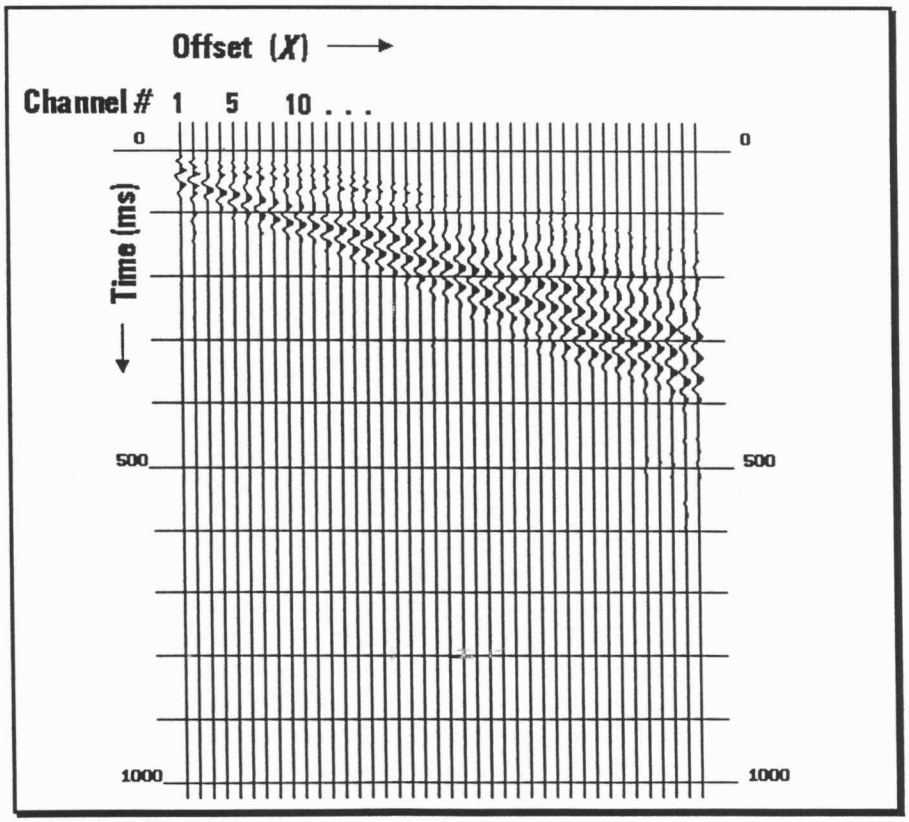
SURFACE-WAVE RESEARCH
AT
KANSAS GEOLOGICAL SURVEY (KGS)

- Development of Utilization Techniques
- Data-Acquisition and Processing Techniques
- Emphasis on Utilization in Engineering Projects
- Multi-Channel Recording Method

MULTI-CHANNEL RECORDING

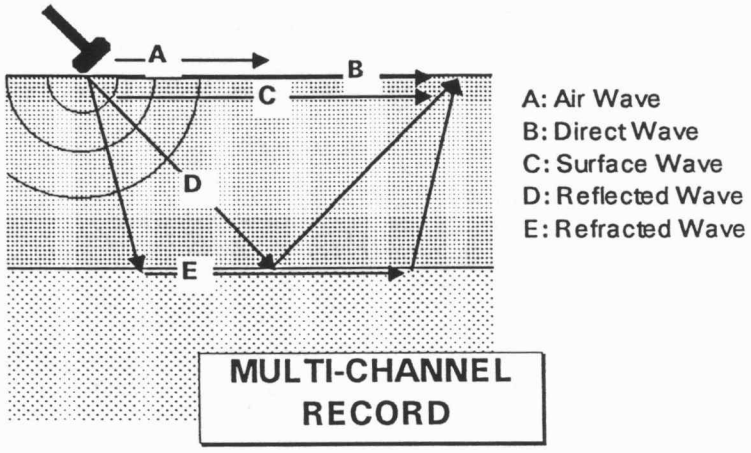


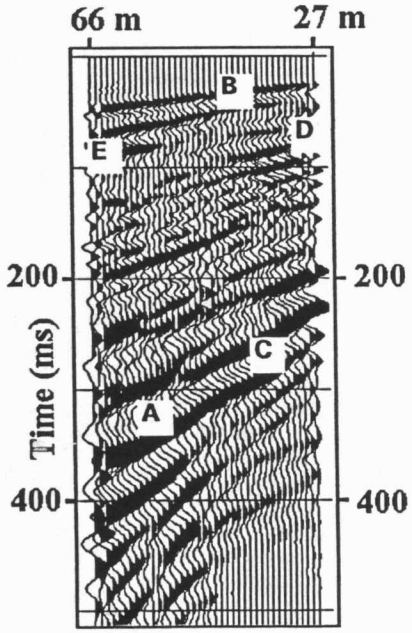
Multi-Channel Record



MULTI-CHANNEL RECORDING — ADVANTAGES

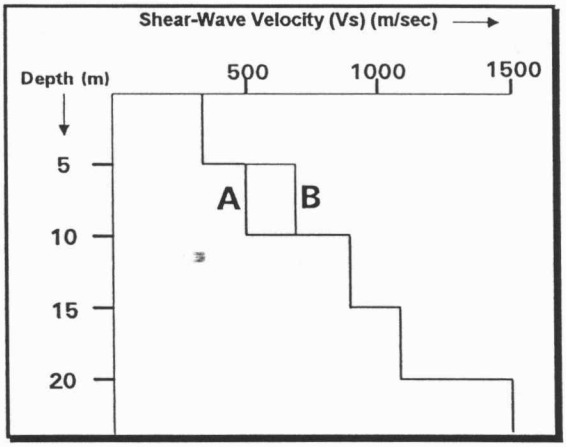
- Coherency Checking — Efficient Quality Control
- Redundancy in Measurement — High Signal-to-Noise Ratio





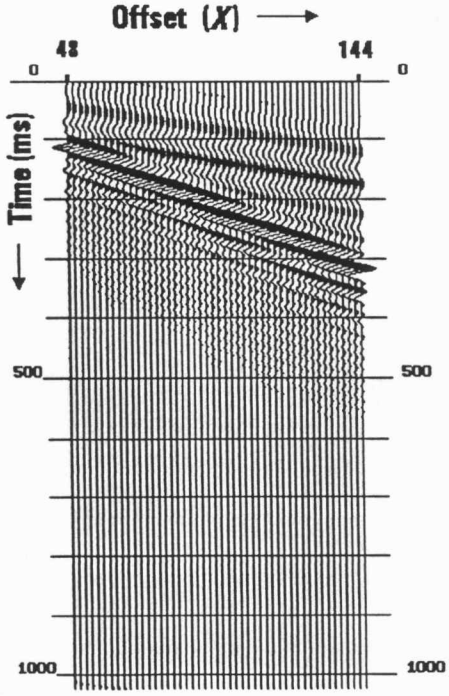
MULTI-CHANNEL RECORDING — COHERENCY

Velocity Model

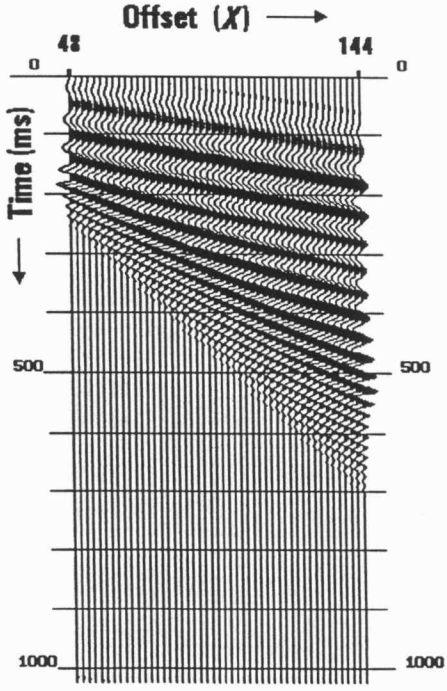


Coherency on Multi-Channel Record

A



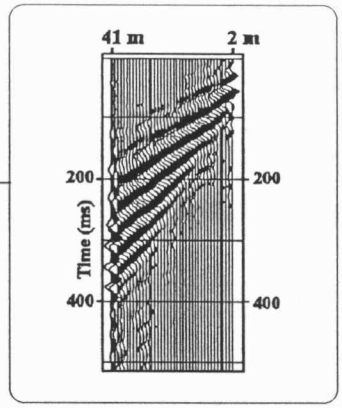
B



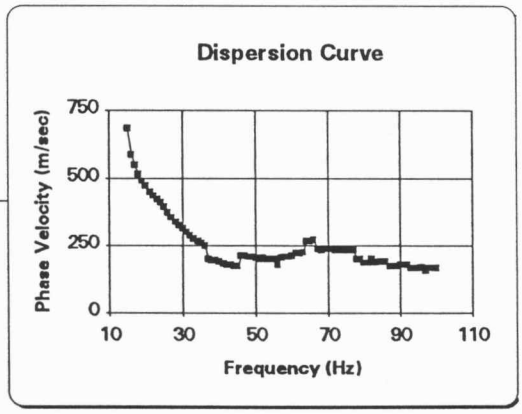
UTILIZATION OF SURFACE WAVES — Vs PROFILING

General Procedure

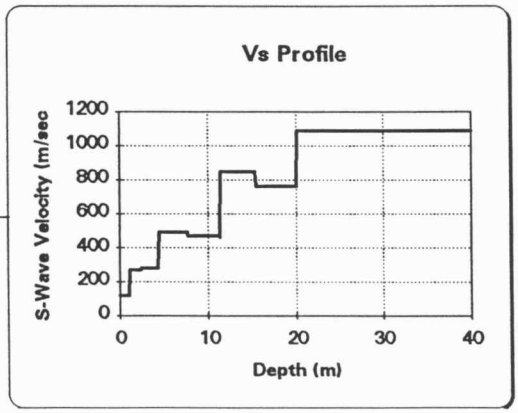
Data Collection (Multi-Channel Recording)



Construction of Dispersion Curve



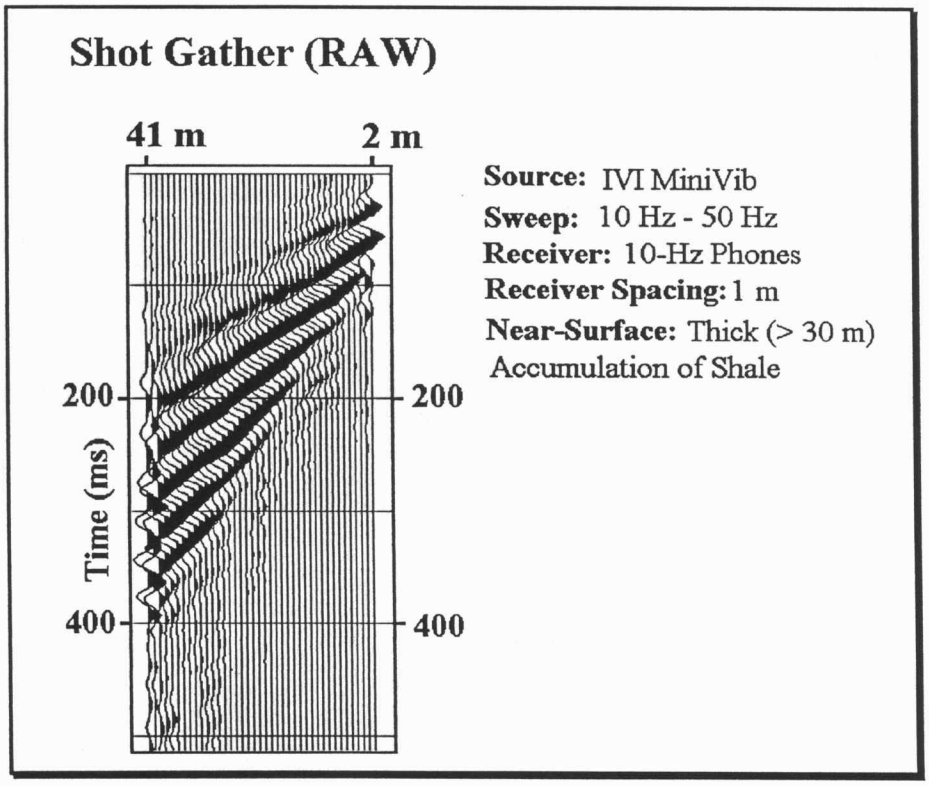
Inversion for Vs Profile



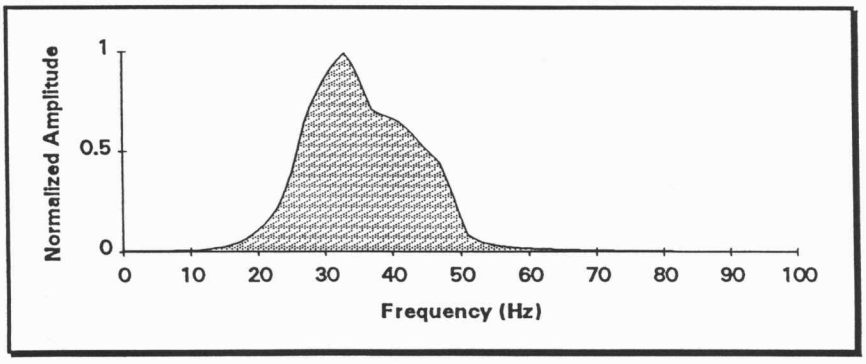
CASE STUDY (Vs PROFILING)

Kansas Geological Survey, Lawrence, Kansas

Shot Gather (Multi-Channel Record)

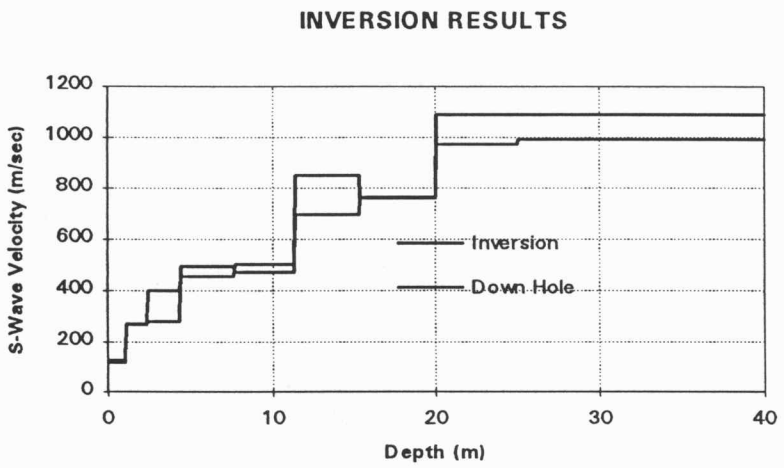


Spectrum

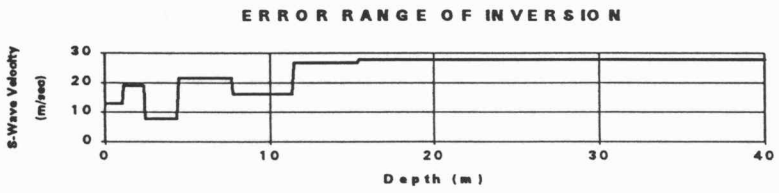


RESULTS OF Vs PROFILING — KANSAS GEOLOGICAL SURVEY

Vs Profiles (Inversion and Down Hole)

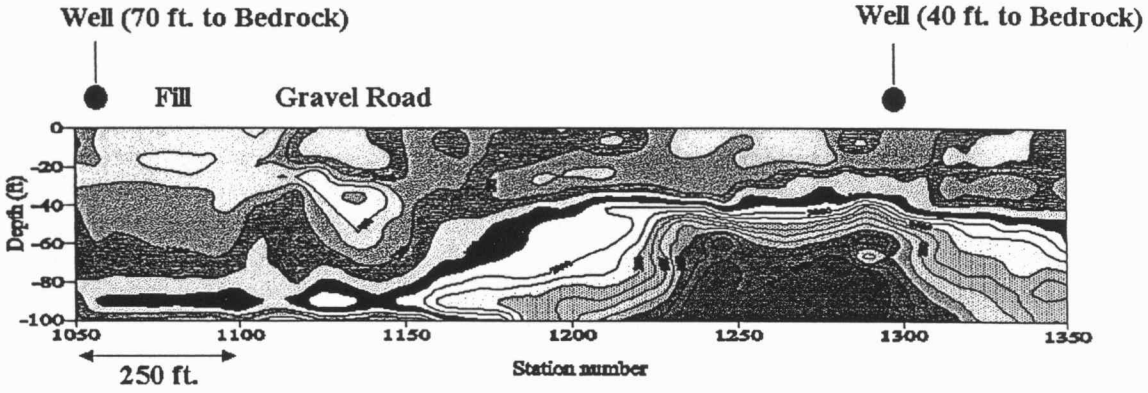


Error Range



CASE STUDY (IMAGING NEAR SURFACE) — CROSS SECTIONAL IMAGE OF Vs

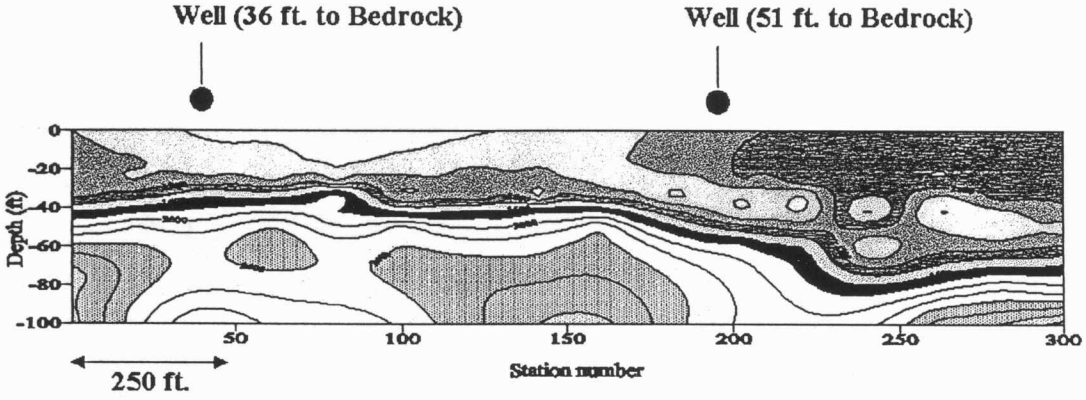
Joplin, MO — Line 1



*Patent Pending on This Technique

CASE STUDY (IMAGING NEAR SURFACE) — CROSS SECTIONAL IMAGE OF Vs

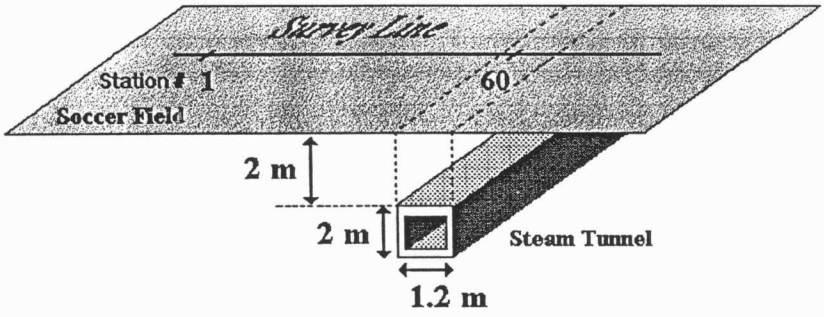
Joplin, MO — Line 2

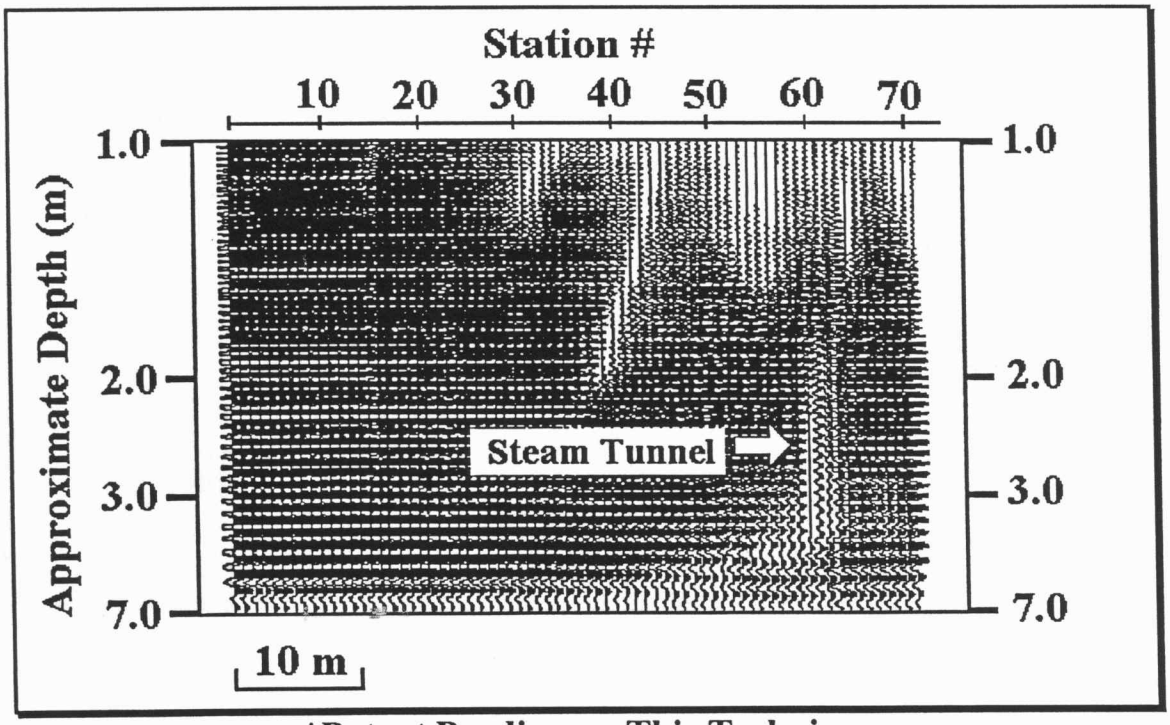


*Patent Pending on This Technique

CASE STUDY (IMAGING NEAR-SURFACE) – IMAGING STEAM TUNNEL

University of Kansas, Lawrence, KS

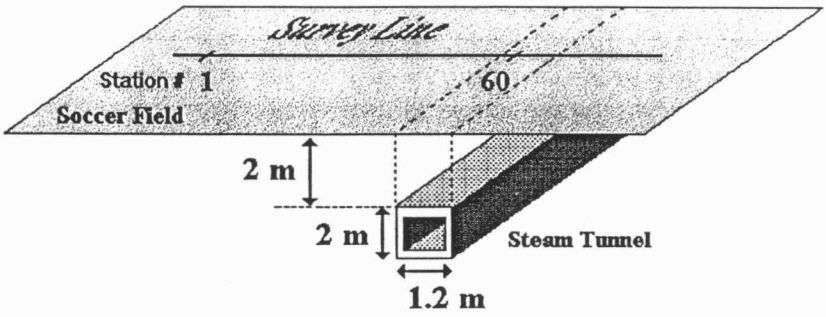




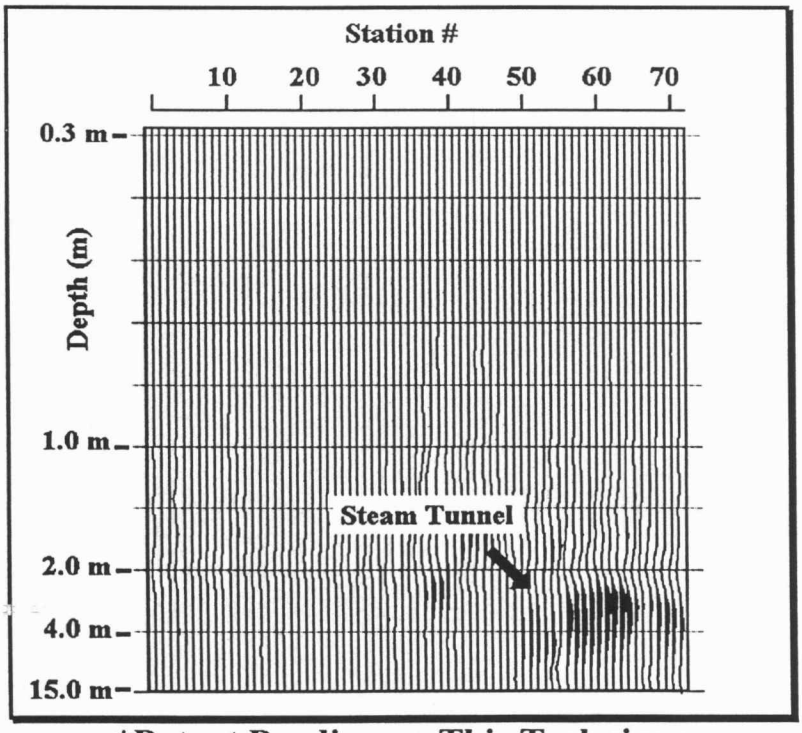
*Patent Pending on This Technique

SURFACE-WAVE ATTRIBUTE ANALYSIS

Steam Tunnel at KU Campus, Lawrence, Kansas



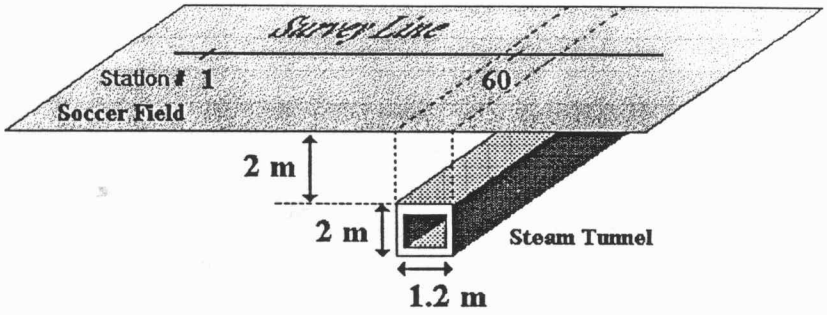
Amplitude Analysis



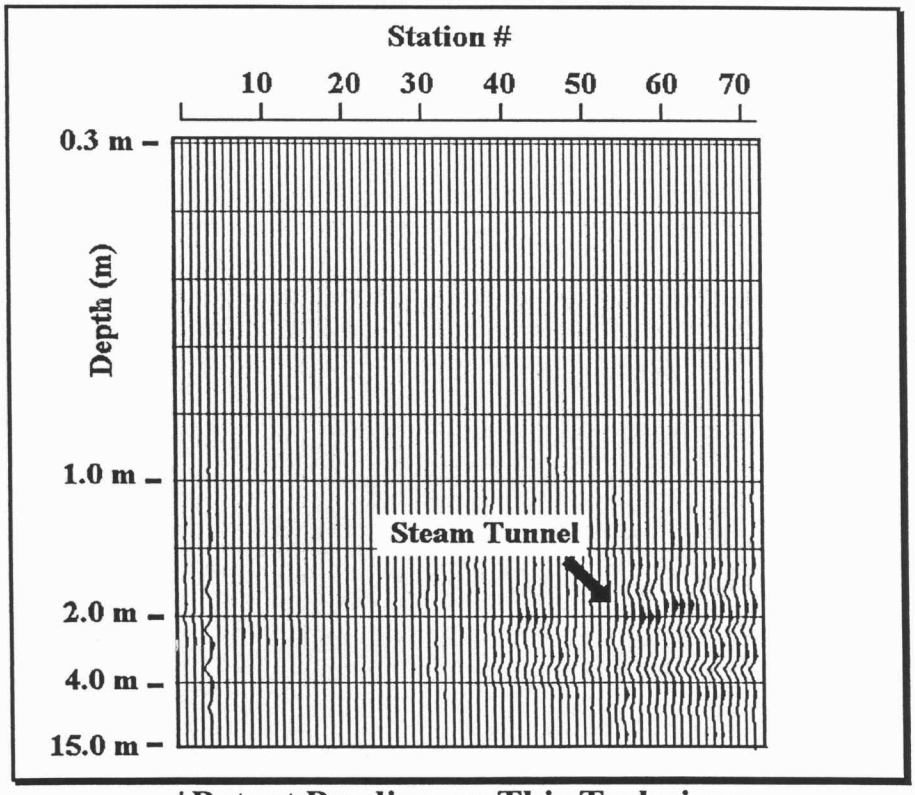
*Patent Pending on This Technique

SURFACE-WAVE ATTRIBUTE ANALYSIS

Steam Tunnel at KU Campus, Lawrence, Kansas



Phase Analysis



*Patent Pending on This Technique

SURFACE-WAVE IMAGING — TWO METHODS

Steam Tunnel at KU Campus, Lawrence, Kansas

Image by Stacking

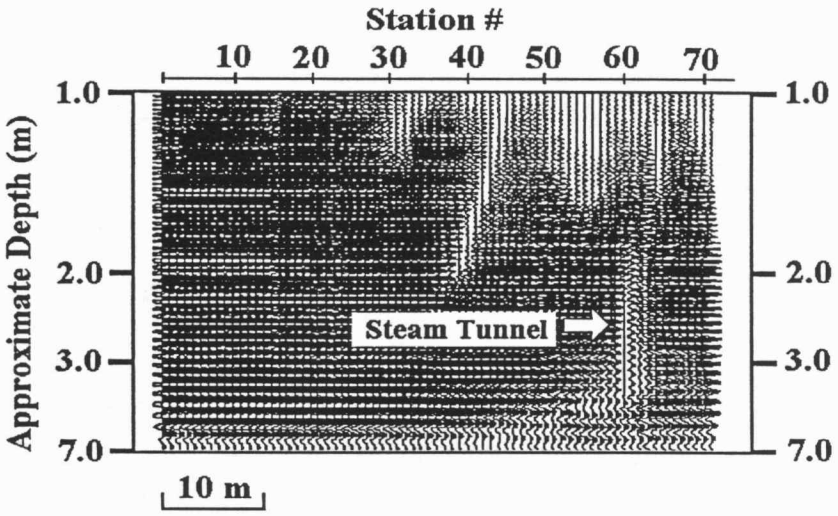
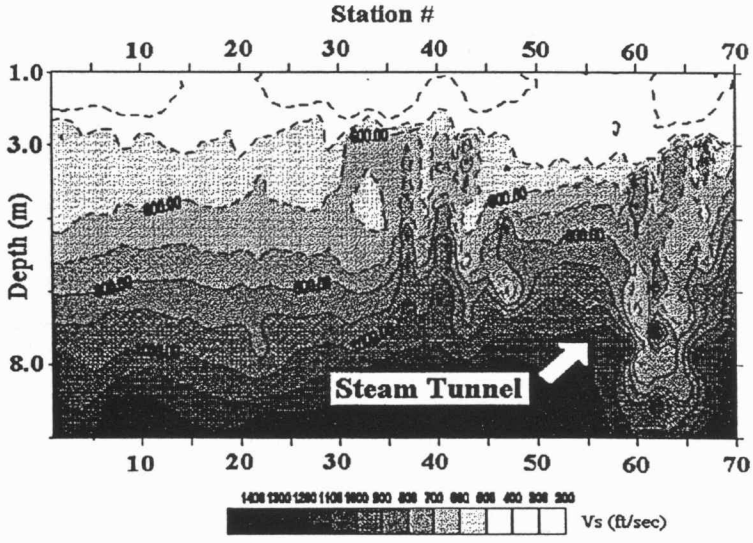


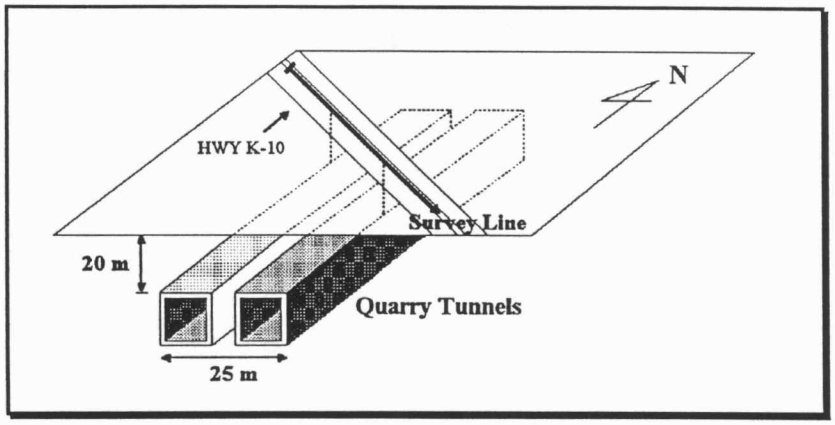
Image by Contouring



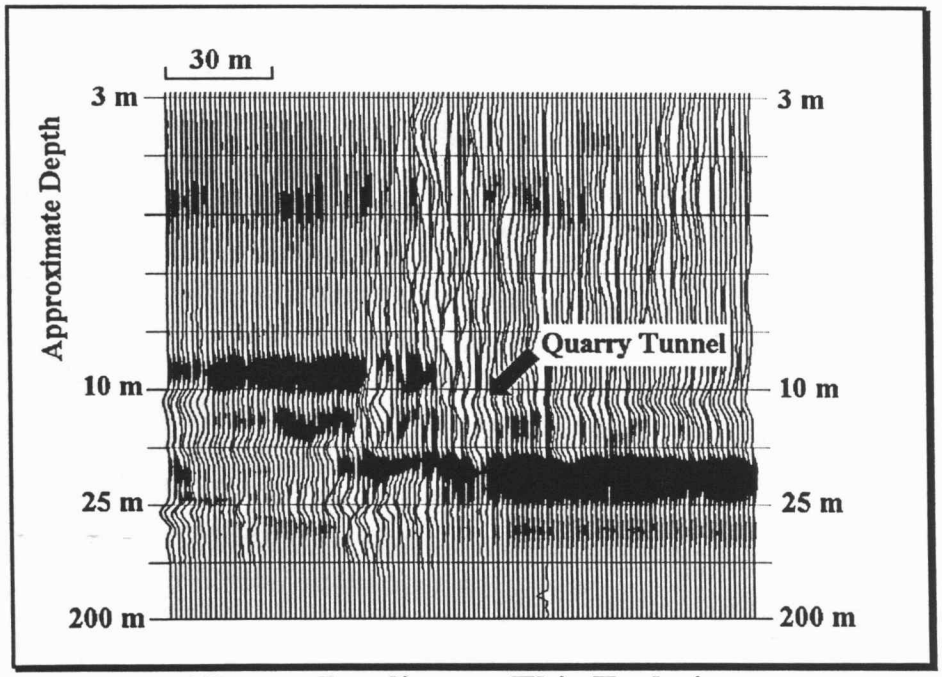
*Patent Pending on This Technique

SURFACE WAVE — CASE STUDY

Limestone Quarry Tunnel Below K-10 Highway
Lenexa, Kansas



Surface-Wave Attribute (Amplitude) Analysis

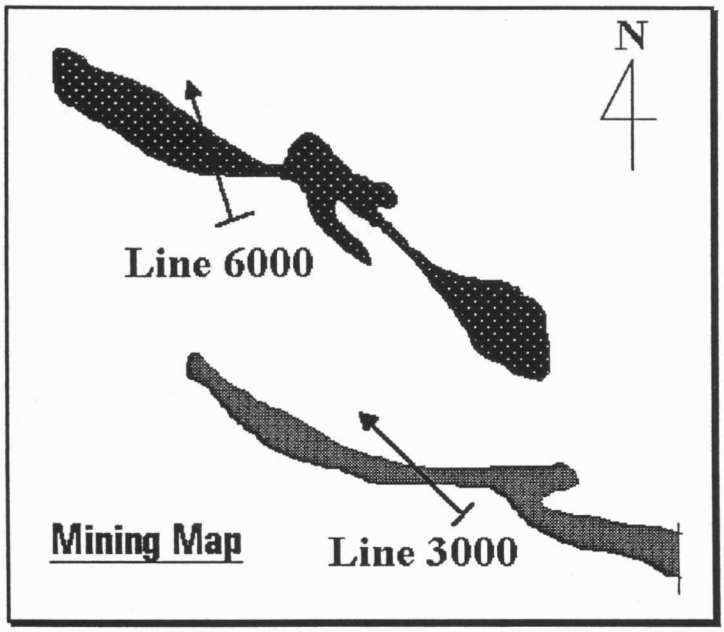


*Patent Pending on This Technique

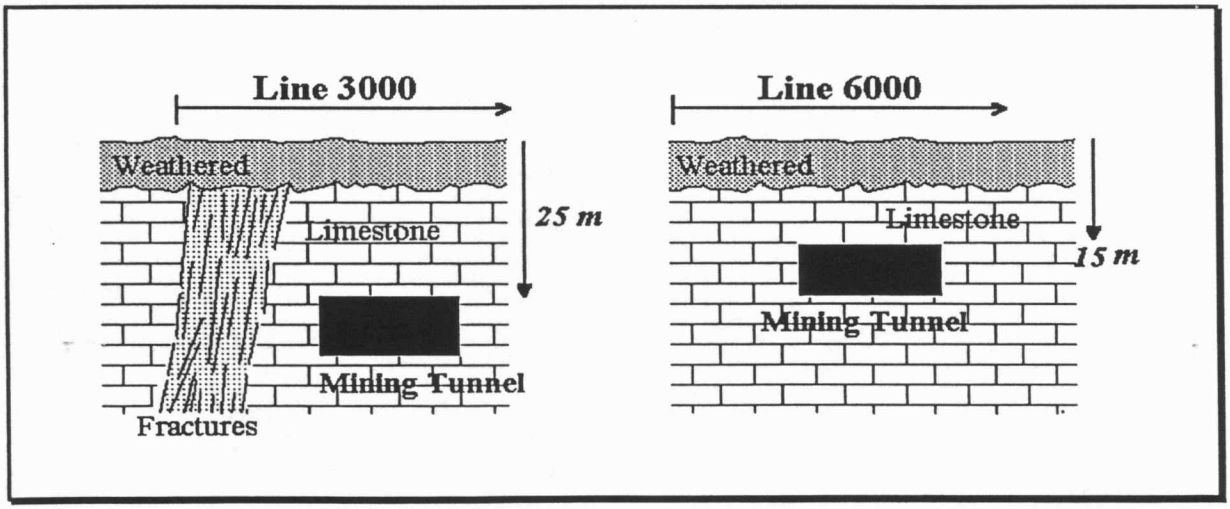
SURFACE WAVE — CASE STUDY

Lead-Zinc Mine Detection, Joplin, MO

Mining Map

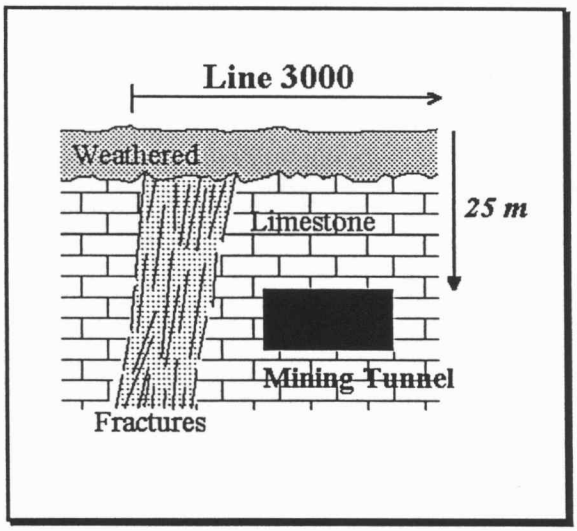


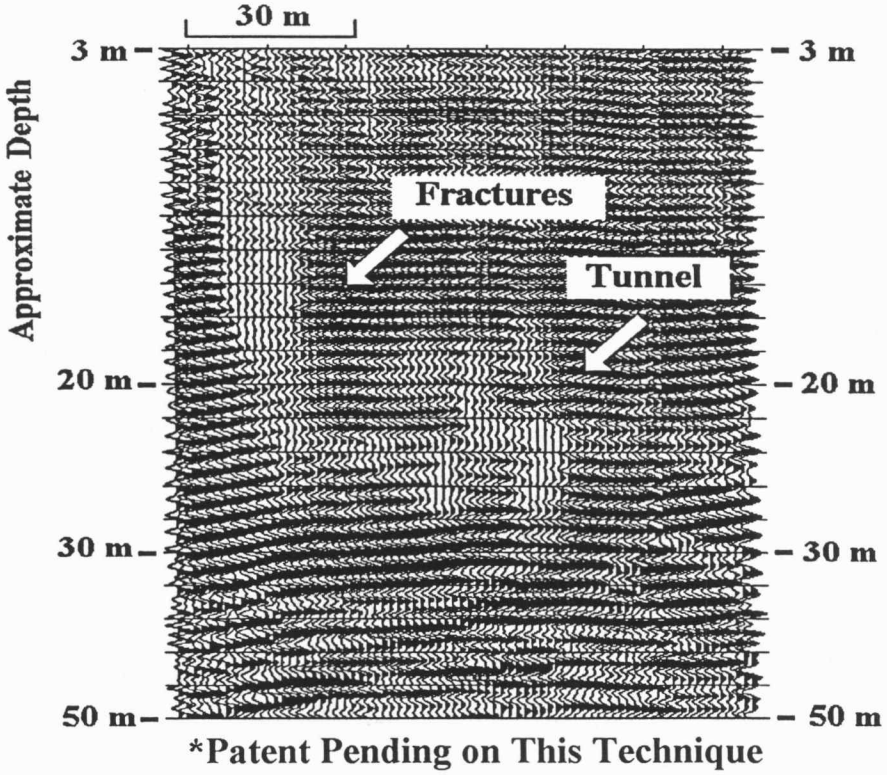
Cross Section



SURFACE WAVE — CASE STUDY

Lead-Zinc Mine Detection, Joplin, MO — Line 3000

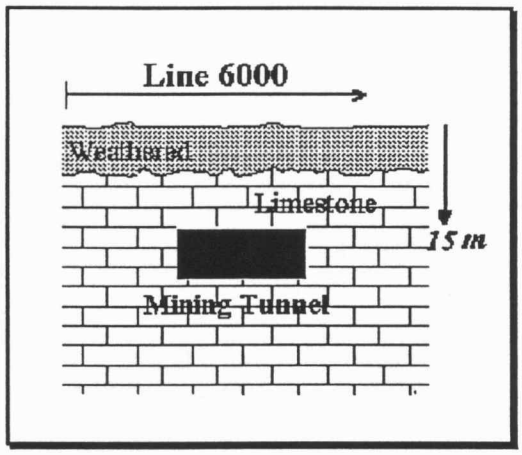


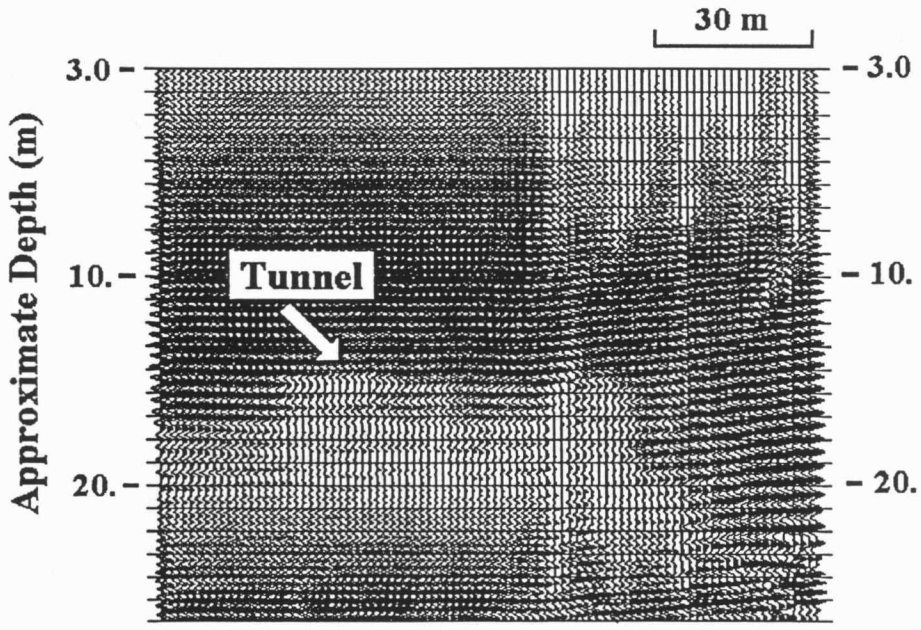


*Patent Pending on This Technique

SURFACE WAVE — CASE STUDY

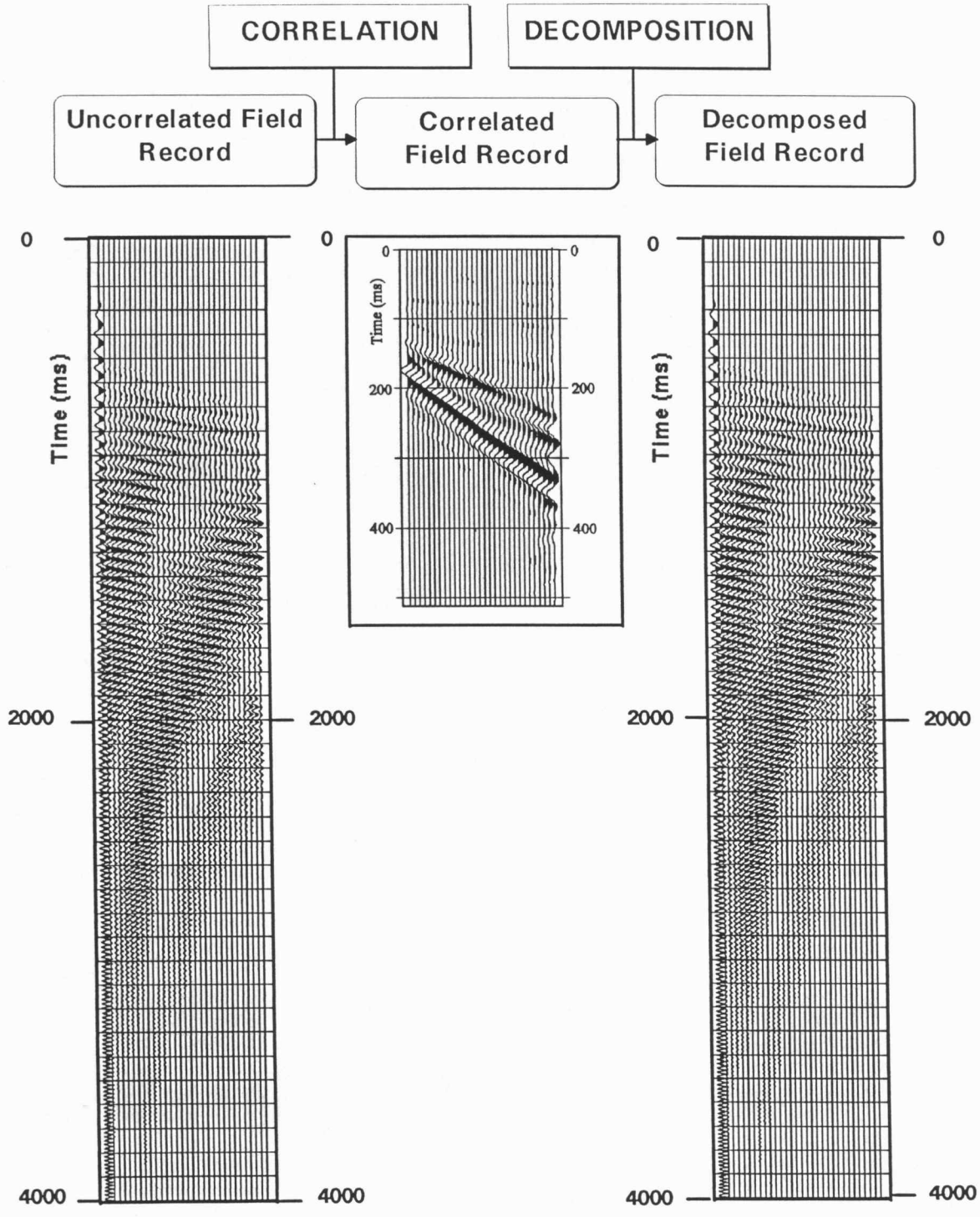
Lead-Zinc Mine Detection, Joplin, MO — Line 6000



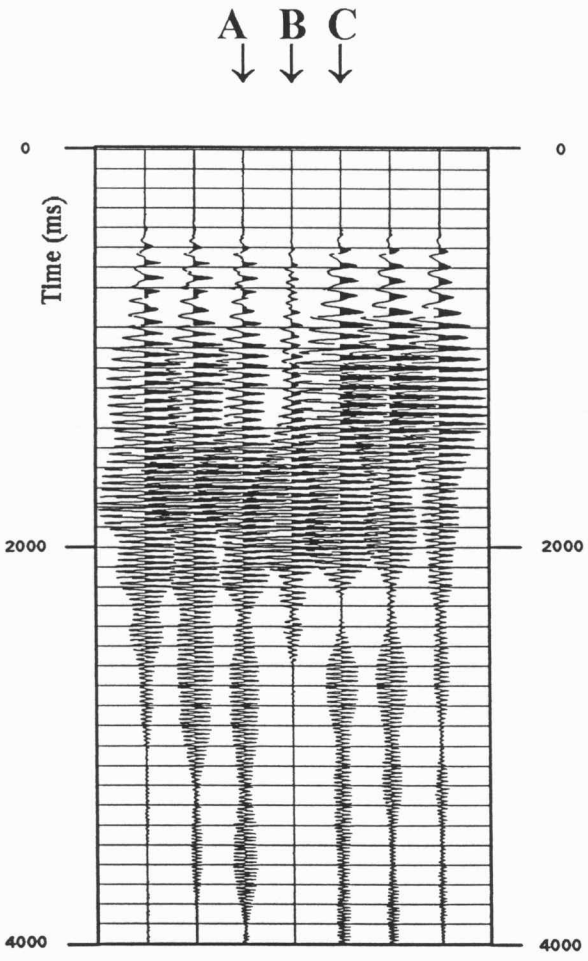


*Patent Pending on This Technique

TRANSFORMATION
FROM SLEDGE-HAMMER INTO VIBROSEIS

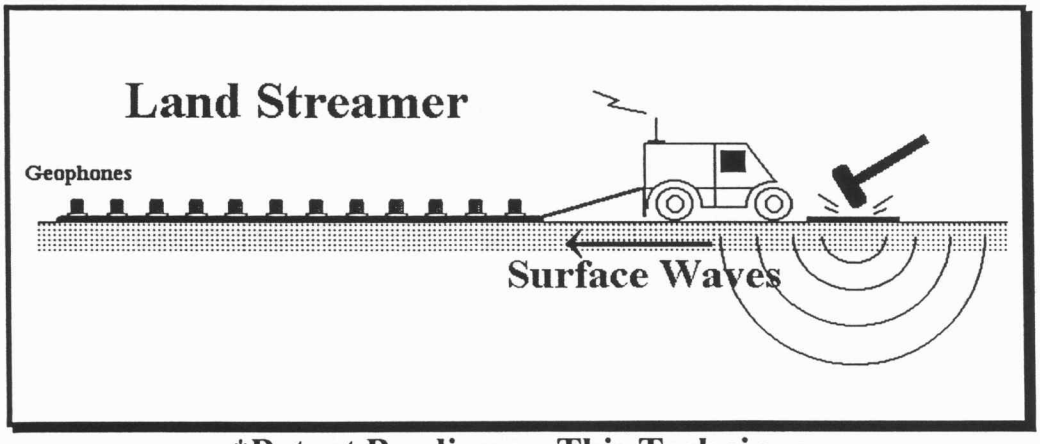


LAND STREAMER —
FAST AND AUTOMATIC DATA COLLECTION



A & C: Geophone planted in 40-lb dirt sack

B: Geophone planted in a hardboard box filled with 10-lb dirt



***Patent Pending on This Technique**

CONCLUSIONS

If surface-wave data are collected and processed through proper multi-channel recording and processing techniques, followings are possible:

- **Shear-Wave velocity (Vs) profiles can be obtained in time-efficient and accurate manner through multi-channel recording and processing techniques.**

- **Both one dimensional (1-D) and two dimensional (2-D) profiles of near-surface elastic properties can be obtained.**

- **The variety of analysis technique gives a better chance to achieve the survey goal.**

FRAMEWORK OF *MASW.EXE*